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Increasing the Intelligence of Virtual Sales Assistants through Knowledge Modeling Techniques

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Abstract

Shopping agents are web-based applications that help consumers to find appropriate products in the context of e-commerce. In this paper we argue about the utility of advanced model-based techniques that recently have been proposed in the fields of Artificial Intelligence and Knowledge Engineering, in order to increase the level of support provided by this type of applications. We illustrate this approach with a virtual sales assistant that dynamically configures a product according to the needs and preferences of customers.

1 Introduction

The last generation of web-based applications in the context of e-commerce is oriented to provide more services to merchants and consumers using advanced techniques such as knowledge-based approach, natural language, multimedia presentations, etc. In this context, a special kind of *shopping agent* [1] is conceived as a virtual sales assistant that automatically simulates part of the behavior of an employee of a company to help a customer in finding and selecting an appropriate product according to particular needs. In order to provide an adequate support, the assistant must combine deep knowledge about the products, the consumer and the company. The complexity of all this expertise requires a flexible and efficient computational organization using appropriate symbolic representations and inference procedures that simulate the variety of reasoning processes. These processes include, for example, the interpretation of customer needs, classification of the customer, selection of types of products based on customer needs, justification of proposed products and even the dynamic configuration of products.

According to this, this paper argues about the utility of recent advances in the field of knowledge engineering that can significantly improve the type of services. In particular, the field of model-based development of intelligent systems can provide efficient solutions in this area. Thus, this paper presents, first, a summary of the recent proposals in the field of model-based development of knowledge systems. Then, the paper presents how this technology can help in building advanced intelligent sales assistants and illustrates this approach with a case of a virtual sales assistant that dynamically configures products according to the needs of customers.

2 The model-based approach in knowledge engineering

The knowledge engineering field has recently proposed a new generation of methods and techniques that can significantly decrease the effort of building large and complex knowledge

systems. One of the important ideas of this new generation of solutions is that it is useful to use a modeling approach for building build a knowledge system. According to this, a knowledge model is formulated as an abstraction of the knowledge that an observer (the knowledge engineer) ascribes to a human expert to support a particular problem-solving competence. This modeling approach considers the existence of a logical level, proposed by Newell with the name of *knowledge level* [2], at which the knowledge is described on the basis of its role, independently on the particular symbolic representation. This view contrasts to the traditional approach where a knowledge system was usually considered as a container to be filled with knowledge extracted from an expert. Some recent methodologies for system development follow this model-based approach (CommonKADS [3] or Protégé-II [4]). These methodologies organize the knowledge according to certain structuring principles. One organization followed by most of the methodologies is the task-oriented approach which was originally present in several proposals from different authors such as the *generic task* [5,6], the *KADS conceptual model* [7], the model of *components of expertise* [8], the *role limiting method* [9] and the *structures of inferences* of J. Clancey [10].

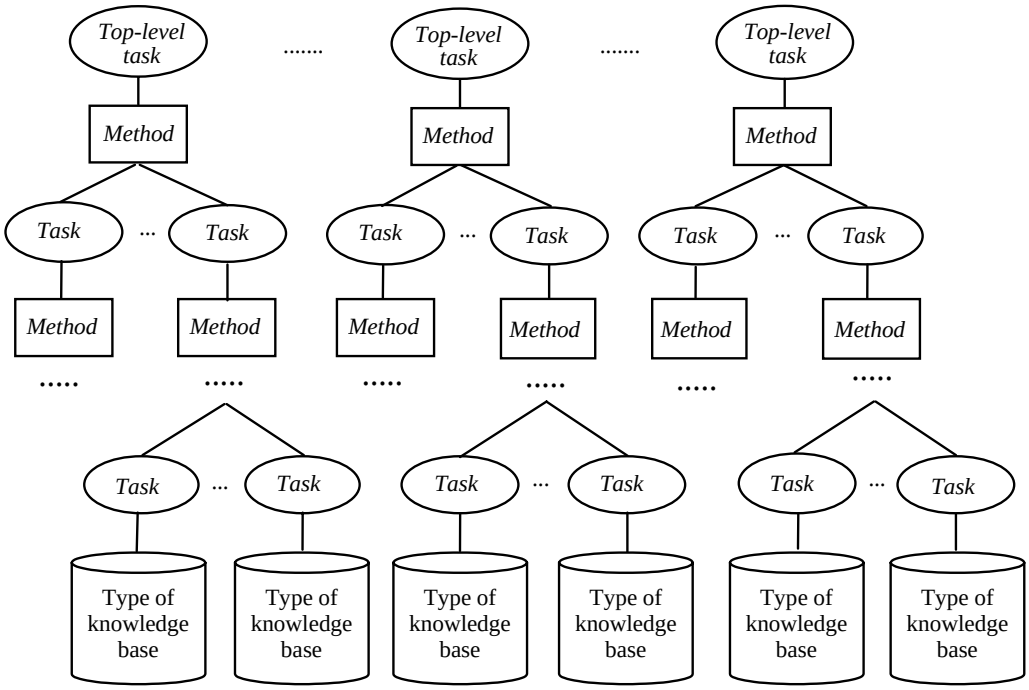

Figure 1: Hierarchies of task-method-domain structures to describe a knowledge model.

According to this view, a *task* identifies a goal to be achieved (for instance, the design of the machinery of an elevator). Tasks are usually characterized by the classes of premises that they receive as input and the classes of conclusions that they produce as output. On the other hand, a *method* indicates how a task is achieved, by describing the different reasoning steps (sub-tasks) by which its inputs are transformed into outputs. Thus, a knowledge model can be described initially as a collection of *top-level tasks* that identify the set of main goals to be achieved by the application. These tasks require compound methods that decompose them into subtasks. These subtasks may again be decomposed by a method and so on, developing a task-method-domain hierarchy (figure 1). At the bottom level of this hierarchy there are primary tasks that are not decomposed into simpler sub-tasks. Primary tasks rely on a type of knowledge base modeling the declarative domain knowledge (each one with its own symbolic representation). The modeling approach also provides libraries of standard reasoning methods (called *problem solving methods* PSM) for classes of problems conceived as templates of

knowledge-based applications that can serve as a guide to develop new applications and, therefore, decrease the effort of knowledge acquisition.

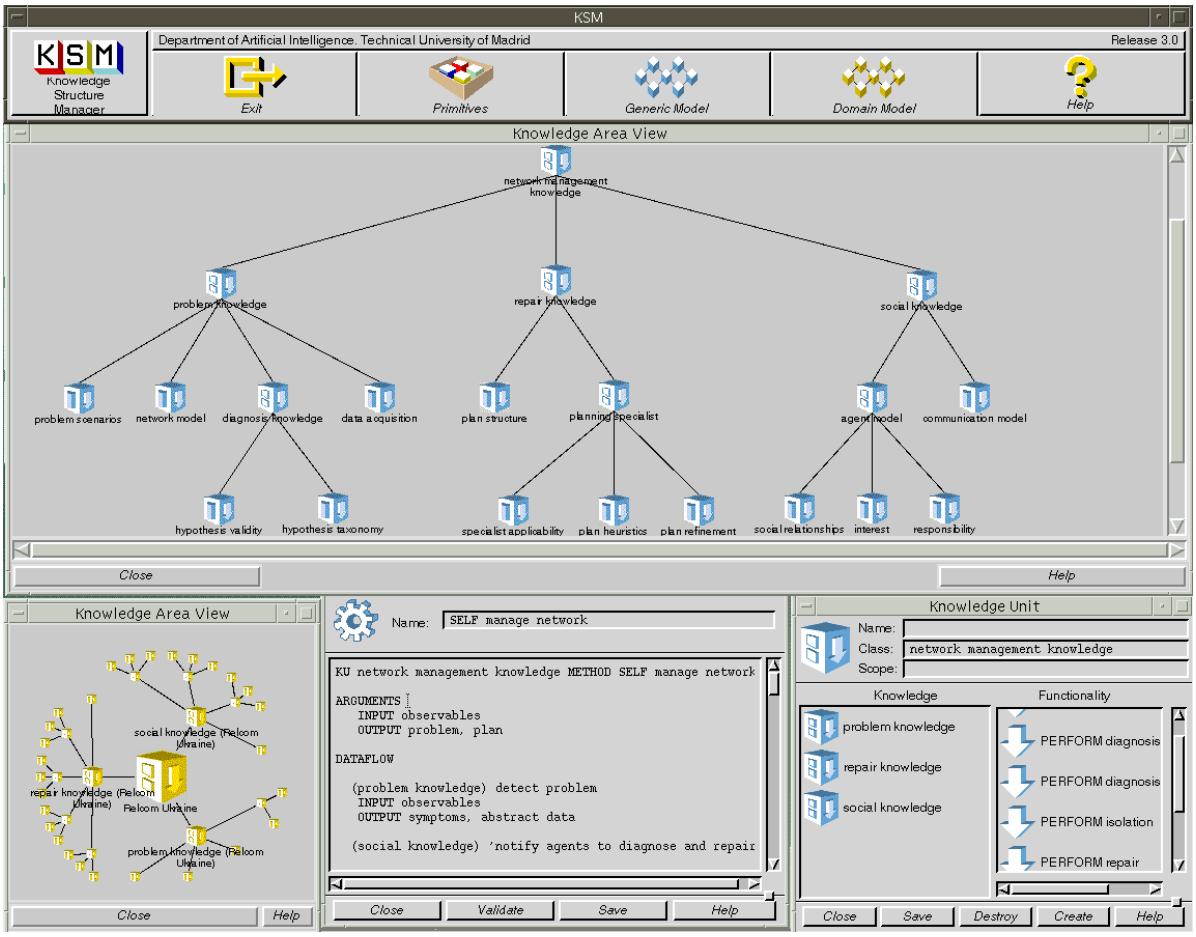

Figure 2: Example of user interface of the KSM software environment.

To develop the operational version of such models, it is very useful to use specific software tools. For example, it is possible to use environments such as KSM (Knowledge Structure Manager) [11] (figure 2), developed by our group and applied in the development of several real-world projects. KSM produces the operational version using knowledge-based software components and help developers and end-users in creating and maintaining complex sets of knowledge bases with different symbolic representations. This approach naturally combines with agent-based techniques [12].

3 Application to Virtual Sales Assistants

The model-based development for knowledge systems can be very appropriate to develop a virtual sales advisor. This advisor can be considered as an *intelligent assistant* [13] that helps the user in making decisions. This approach usually requires complex knowledge-based designs with multiple knowledge bases that need to be adequately structured using flexible strategies of inference that simulate intricate reasoning processes.

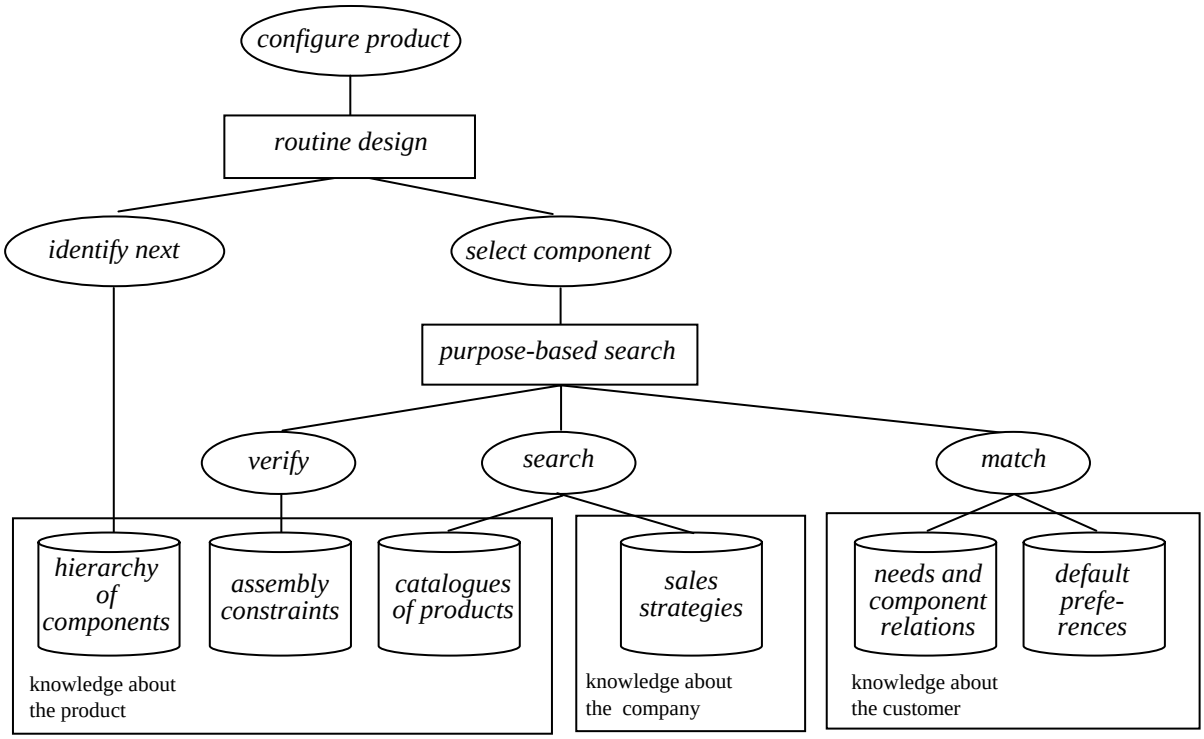

Figure 3: Refinement of the configuration task for the sales assistant.

To cope with this, we applied a model approach following several steps. First, each service provided by the intelligent assistant was considered as a top-level task (the set of services provided by the assistant is viewed in a context of a dialogue between customer and assistant directed to find appropriate products). Second, each task was refined by using problem-solving methods (PSMs). For this purpose, standard general PSMs from the knowledge engineering literature can be used (for classification, diagnosis, configuration, prediction, etc.) to guide this process together with new methods designed for the particular problem. This refinement process ends with primary tasks that are based on types of knowledge bases that identify the domain knowledge to support all the process. This refinement process requires adding also control knowledge to cope with contradictory criteria. Finally, the last step is oriented to implement the system. This includes selecting specific symbolic representation and inference procedures, and programming the corresponding software components. For this last phase, it is very appropriate to use knowledge modeling tools such as KSM that provides advanced utilities for knowledge representation together with reusable preprogrammed software components.

According to this approach, we developed a web-based application that provides an advanced service by simulating how a sales assistant configures a product by interpreting the needs and preferences of the customer. This application simulates the conversation process between a customer and a sales assistant with prefixed types of questions and includes the capacity of dynamically configuring the product. Thus, the sales assistant must find a collection of single components that, together, could satisfy the needs of the client. We applied this design to the case of equipment of photography, although the general software architecture is being considered for other types of domains (e.g., dynamic configuration of computer hardware, etc.).

In more detail, the services that we identified for this type of virtual sales assistant are: acquire customer needs, propose a candidate product, justify the product utility, modify a product, and compare products. This set of types of tasks supports a line of negotiation between customer and the sales assistant that could be summarized in the following steps: (1) the seller asks for the customer needs, (2) the seller proposes a candidate product, (3) the customer asks for details about the product (components, price, etc.), (3) the seller justifies the selected product, (4) the customer asks for modifications of the product (lower price, special firm, etc.) or comparison between products. This cycle is repeated from 3 until the customer decides to buy one product or, on the contrary, rejects the proposals.

Figure 4: Example of windows presented by the web-based virtual sales assistant for photography equipment (Spanish language).

In order to provide such a support, an efficient combination of knowledge bases and inference procedures is required. The model includes the explicit representation of three kinds of knowledge: (1) *the customer*, that allows the system to find candidate components that could satisfy the customer, (2) *the company*, that allows the system to select the products according to the interests of the company, (3) *the product*, that allows the system to find consistent configurations of products. Figure 3 shows part of the model designed to carry out one of the tasks: *configure products*. The figure shows a hierarchy of tasks and methods with types of knowledge bases at the bottom. The top-level task is carried out by an adaptation of a general PSM called *routine design* [14]. The basic idea of this method is to divide the whole design decision in partial classification tasks corresponding to the different components. Within each component, verification about design constraints needs to be done. The whole design is found through a tentative search that proposes hypotheses of design that can be rejected when the corresponding constraints are not satisfied, which forces to backtrack in order to propose alternative designs.

4 Conclusion

In summary, this paper argues about the utility of recent knowledge modeling techniques according to the recent advances in the field of artificial intelligence and knowledge engineering, in order to increase the level of support provided by virtual sales assistants in the context of web-based e-commerce applications.

The paper summarizes the recent advances in the field of knowledge modeling and shows how they can be applied in the context of sales assistance. An application is presented as a sales assistant in the field of equipment of photography. The application provides advanced support by simulating the seller behavior during the negotiation with the customer and, dynamically, constructs the product by assembling components, according to the customer needs. This requires a particular complex combination of knowledge bases and inference procedures that can be supported by knowledge modeling tools such as KSM (Knowledge Structure Manager).

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